

REMARKS

This Amendment is fully responsive to the final Office Action dated December 19, 2011 and the Advisory Action dated April 5, 2012, issued in connection with the above-identified application. A request for continued examination (RCE) and the fee for a one-month extension of time are included. Claims 2, 3 and 5 are pending in the present application. With this Amendment, claims 2, 3 and 5 have been amended. No new matter has been introduced by the amendments made to the claims. Favorable reconsideration is respectfully requested.

The Applicants have amended the specification to correct a typographical error. Specifically, the sensitivity wavelength range of 190 to 1100 um on page 11 in line 17 has been changed to 190 to 1100nm. An amended portion of the specification is provided. No new matter has been introduced by the amendments made to the specification.

In the Office Action, claims 2, 3 and 5 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Tsukamoto et al. (US 2004/0026381, hereafter “Tsukamoto”) in view of Terada et al. (US 5,155,329, hereafter “Terada”), Chou et al. (US 5,961,859, hereafter “Chou”) and Kearney (US 4,446,354, hereafter “Kearney”).

Additionally, on the continuation page of the Advisory Action, the Examiner alleges that the detection of ultraviolet radiation (as in the present invention) instead of the detection of infrared radiation (as in Terada) as argued by the Applicants is not specifically recited in the independent claims.

Accordingly, the Applicants have amended independent claims 2 and 3 to include the features of detecting and analyzing ultraviolet light emission.

For example, independent claim 2 (as amended) recites *inter alia* the following features:

“A laser welding method, comprising:..

detecting a time change in ultraviolet light emission strength of a plasma or a plume generated from a laser welded portion;

analyzing frequency characteristics of the ultraviolet light emission to obtain an amplitude of a frequency component which is a same variation frequency of the laser output....” (Emphasis added).

The features emphasized above in independent claim 2 are similarly recited in independent claim 3 (as amended). Additionally, the features emphasized above in independent claim 2 (and similarly recited in independent claim 3) are fully supported by the Applicants’

disclosure.

The present invention (as recited in independent claims 2 and 3) detects and analyzes the time change in light emission strength of a plasma or plume generated from a laser welded portion, and determines and sets the optimum laser output modulation condition. With the present invention (as recited in independent claims 2 and 3), the ultraviolet light emission of the plasma or plume is detected and analyzed.

In the Office Action, although the Examiner relies on the combination of Tsukamoto, Terada, Chou and Kearney for disclosing or suggesting all the features recited in independent claims 2 and 3, the Examiner relies specifically on Terada, Chou and Kearney for disclosing or suggesting the detection of the time change in light emission strength of a plasma or plume generated from a laser welded portion, and the determination of the optimum laser output modulation conditions.

Specifically, the Examiner relies on Figs. 4 and 6, and col. 4, lines 33-43 of Terada; col. 3, lines 8-18 of Chou; and Kearney generally.

Terada, with reference to Figs. 4 and 6, discloses a relationship between a waveform of the pulsating laser beam and a waveform of the emission intensity at a weld zone. As described in Terada, the waveform related to emission intensity stays at a certain level while the welding beam input is present, and decreases abruptly a short time after the welding beam input drops (see also col. 4, lines 33-43).

Additionally, Terada in col. 4, lines 63-66 discloses that a predetermined wavelength used in filtering the light emitted at the molten pool can be determined by performing weld testing, spectrum analysis and data processing. As described in Terada, strong ultraviolet radiation emitted from the plume or plasma can be a large source of noise with regard to the detection of the infrared radiation emitted from the molten pool. Therefore, Terada discloses using an interference filter that can transmit only the infrared radiation of the molten pool. Thus, the intensity of the infrared radiation from the molten pool is clearly detected in Terada, which is completely different from the present invention (as recited in independent claims 2 and 3).

With the present invention (as recited in independent claims 2 and 3), the intensity of the infrared radiation is not detected but, instead, the ultraviolet radiation is detected.

Moreover, the Applicants assert that Chou and Kearney fail to overcome the deficiencies noted above in Terada. Chou in col. 3, lines 8-18 discloses a method of monitoring laser weld

quality. However, in Chou (i.e., in col. 3, lines 8-18), a light emitted from the weld plasma above the surface of a workpiece irradiated by a laser beam is monitored. Chou fails to disclose or suggest detecting the time change in light emission strength (i.e., the ultraviolet radiation) of a plasma or plume generated from a laser welded portion, and determining and setting the optimum laser output modulation condition based on such detection.

In the Office Action, the Examiner alleges that Kearney discloses that it is well known that the amplitude and wavelength of radiation emitted by a welding arc or plasma is detected by a sensor to determine weld conditions. However, the Applicants assert that Kearney still fails to disclose or suggest a method of detecting and analyzing the time change in light emission strength of a plasma or plume (i.e., the ultraviolet radiation), and determining and setting the optimum laser output modulation condition, as recited in independent claims 2 and 3.

Based on the above discussion, no combination of Tsukamoto, Terada, Chou and Kearney would result in, or otherwise render obvious, the features of independent claims 2 and 3. Likewise, no combination of Tsukamoto, Terada, Chou and Kearney would result in, or otherwise render obvious, the features of claim 5 by virtue of its dependency from independent claim 2.

In light of the above, the Applicants submit that all the pending claims are patentable over the prior art of record. The Applicants respectfully request that the Examiner withdraw the rejections presented in the outstanding Office Action, and pass the present application to issue. The Examiner is invited to contact the undersigned attorney by telephone to resolve any issues remaining in the application.

Respectfully submitted,

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